BOTANICAL SURVEY
OF PROPOSED NEW WELL SITE #2
BLNR DESIGNATED GEOTHERMAL RESOURCE SUBZONE
MIDDLE EAST RIFT ZONE OF KILAUEA,
PUNA DISTRICT, ISLAND OF HAWAI'I

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by

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PREPARED FOR:

TRUE GEOTHERMAL ENERGY COMPANY

and

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INTRODUCTION

On 12 August 1990 a botanical survey was conducted of the proposed new Well Site adjacent to the access road to Well Site 1.

METHODOLOGY

The new Well Site is proposed to occupy an area of between 3.5 and 4 acres located within a marked 400 X 400 foot area immediately adjacent to and south of the present road leading from the property boundary to Well Site 1.

At the proposed new well site I examined an area of approximately 800 X 800 feet within which the marked 400 x 400 foot well site was was located.

RESULTS

1. FLORA

All species of vascular plants observed are listed in TABLE I. A total of 73 species and varieties were found, of which 52 (71%) were native, (40 endemic to the Hawaiian Islands; 12 indigenous, native in Hawai'i and elsewhere), and 21 (29%) were species introduced to Hawai'i by humans (1 by the Polynesian settlers, 28 since European contact).

Although a special search was made for the three candidate plants which were formerly proposed for listing as endangered species (U.S. Fish and Wildlife Service, 1980), and which have been reported from the East Rift Zone of Kilauea, (Bobea timonioides, Tetraplasandra hawaiiensis, Adenophorus periens), none was encountered in this survey, and no other plants currently listed or proposed for listing as endangered were found in the surveyed area.

The area surveyed is below the elevation where Adenophorus periens is known to occur in Puna. Furthermore, most of the large 'ohi'a trees in the area belong to the variety macrophylla which has bark that regularly peels off in large strips, and consequently does not develop the thick coating of mosses and liverworts that forms the substrate on which A. periens grows.

Both the Bobea and the Tetraplasandra were encountered along the road leading from the edge of the property to Well Site 1 (Lamoureux, et al., 1987). They grow widely through Puna forests as scattered individuals but were not found in the areas proposed for clearing in the current phase of the project. It should be noted that the new "Manual of the Flowering Plants of Hawai'i", (Wagner, Herbst & Sohmer, 1990), reevaluates the status of the flowering plants which were earlier proposed for listing as endangered, based on the most recent information available on distribution, abundance, and taxonomic classification. On this basis Tetraplasandra hawaiiensis is not considered to be endangered, threatened, or even rare. Bobea timonioides is listed as rare, but not threatened or endangered.

2. VEGETATION

The vegetation in the Puna Geothermal Area has previously been mapped and described (Char & Lamoureux, 1985a, 1985b). The site surveyed here is in "ohia-a(2) forest" as described and mapped in those reports. This forest type was described in earlier reports as "Wet 'ohi'a forest with native species and exotic shrubs", and delimited on the vegetation maps in Char and Lamoureux, (1985a) as "ohia-a(2)". This forest is dominated by 'ohi'a-lehua (three varieties of Metrosideros collina, but primarily the variety macrophylla), which forms the canopy layer. Trees are mature, ranging from 20 to 60 feet in height. In a few places the canopy is closed (>60% cover) with most or all trees healthy, in most places the canopy is more open, and in many places most of the canopy trees are dead or declining and dying. In other words there are patches of 'ohi'a dieback in the forest. The subcanopy is dominated in most places by introduced species, primarily strawberry guava (Psidium cattleianum). The major native subcanopy tree is kopiko (Psychotria

hawaiiensis), with occasional hame (Antidesma platyphyllum), and a few kawa'u (Ilex anomala), olomea (Perrottetia sandwicensis) and pilo (Coprosma).

The dominant shrub throughout the area is the introduced weedy Malabar melastome (Melastoma malabathricum), but some native shrubs are also present in relatively small numbers, including kanawao (Broussaisia arguta), mamaki (Pipturus hawaiiensis), 'ohelo (Vaccinium calycinum), Clermontia parviflora, and Cyrtandra sp., (the latter primarily in the numerous cracks and crevices which occur at this site). The introduced thimbleberry (Rubus rosaefolius) is a fairly common but relatively inconspicuous small shrub. Tree ferns, (hapu'u (Cibotium glaucum) and hapu'u 'i'i (Cibotium chamissoi)) are common. The more conspicuous ground ferns are two swordferns, the introduced Nephrolepis multiflora (more common) and the native N. exaltata (less common), two introduced woodferns, Christella dentata and C. parasitica, and the endemic ho'i'o Diplazium sandwichianum.

In more closed parts of the forest the trees, tree ferns, and shrubs support dense masses of epiphytes, including many ferns (listed in Table I), mosses and liverworts. In more open places there are extensive patches of uluhe ferns (Dicranopteris emarginata and D. linearis) 3 to 10 feet deep.

Signs of feral pig activity were found throughout the area. In places where pigs have rooted, and in small open wet areas where they have wallowed, are a number of introduced weeds which are usually not found in undisturbed forest. These include a fern (Athyriopsis japonica), Hilograss (Paspalum conjugatum), a sedge (Cyperus haspan), waterpurselane (Ludwigia palustris), St.Johnswort (Hypericum mutilum), and fireweed (Erechtites valerianaefolia).

3. ENDANGERED SPECIES

No endangered plants (either species already listed or species proposed for listing) were found in any of the areas surveyed.

RECOMMENDATIONS

1. The area now contains a large population of introduced woody shrubs and trees, particularly Malabar melastome and strawberry guava, with a few common guava. It is unlikely that construction activities will have much effect on their abundance or distribution. However, there are several other weeds that could increase in numbers and become more widely distributed as a consequence of opening up the forest as construction occurs. These are the species currently associated with disturbed areas, primarily those disturbed by pigs. Other weeds, not now in the area, could also enter. To avoid this we recommend that:

   a. site clearing methods should be planned to involve as little disturbance as possible beyond the edge of the clearing. This might include using soil and rocks from high points to fill in low spots rather than bulldozing them into ridges at the sides of the clearing. Trees should be felled toward the center rather than the edges of the well site in order to minimize cleared but unused areas which support weeds.

   b. the well site be monitored for weeds, and that appropriate weed control methods be used on all cleared areas, in keeping with the proposed weed monitoring/control program.

2. Our observations suggest that unused open areas at the edges of a clearing are prime sites for weed colonization. Most weedy species require high light intensities to grow well, and such sites are open to full sunlight. If such areas are kept shaded they are less likely to be colonized by weeds. Thus as area cleared should be as small as possible consistent with the function of the site, and unused, unsurfaced areas at margins of the clearing should be as small as possible. During construction if trees are simply

bulldozed aside and, with other vegetation, rocks, and soil are piled up into ridges at the edge of the cleaaring, these rubble piles will soon be covered with weeds. Such areas should be kept to a minimum.

3. Some tree ferns (hapu'u and hapu'u-'i'i) will have to be removed during construction. If feasible, the top foot or two of each fern stem, containing the apical bud, should be retained and replanted along existing road margins or at the edge of this clearing. This would help meet the state requirement that any landscaping be done with native species. More importantly, it would provide a quick source of shade on rubble piles and road margins, which should reduce the weed problem.

LITERATURE CITED

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TABLE 1. PLANT SPECIES CHECKLIST

Families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocotyledons, and Dicotyledons. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux's unpublished checklist of Hawaiian ferns; taxonomy and nomenclature of the flowering plants (Monocotyledons and Dicotyledons) follow St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973). For each species the following information is provided:

1. Scientific name with author citation.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of the species. The following symbols are used:
   - E = endemic = native to the Hawaiian Islands only, not occurring naturally elsewhere.
   - I = indigenous = native to the Hawaiian Islands and also to one or more other geographic areas.
   - P = Polynesian = plants of Polynesian introduction; all those plants brought by the Polynesian immigrants prior to contact with the Western world.
   - X = exotic or introduced = not native to the Hawaiian Islands; brought here intentionally or accidentally by humans after Western contact.

TABLE 1. PLANT CHECKLIST: NEW WELL SITE 2 AND ITS ACCESS ROAD.

GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
PTERIDOPHYTES				
	ASPLENIACEAE			
		I	Asplenium lobulatum Mett.	pi'ipi'i-lau-manamana, 'anali'i
	ATHYRIACEAE			
		X	Athyriopsis japonica (Thunb.) Ching	
		E	Diplazium sandwichianum (Presl) Diels	ho'i'o
	DICKSONIACEAE			
		E	Cibotium chamissoi Kaulf.	hapu'u-pi'i
		E	Cibotium glaucum (J. Sm.) Hook. & Arn.	hapu'u
	ELAPHOGLOSSACEAE			
		E	Elaphoglossum alatum Gaud. var. parvisquameum (Skottsb.) Ands. & Crosby	'ekaha-ula, hoe-a-Maui
		E	Elaphoglossum crassifolium (Gaud.) And. & Crosby	'ekaha-ula, hoe-a-Maui
	GLEICHENIACEAE			
		E	Dicranopteris emarginata (Brack.) Rob.	uluhe
		I	Dicranopteris linearis (Burm.) Underw.	uluhe
	GRAMMITACEAE			
		E	Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	pai, palai-huna
		E	Adenophorus pinnatifidus Gaud.	
		E	Adenophorus tamariscinus (Kaulf.) Hook. & Grev. var. tamariscinus	wahine-noho-mauna
		E	Adenophorus tripinnatifidus Gaud.	
		E	Grammitis tenella Kaulf.	kolokolo, mahina-lua
	HYMENOPHYLLACEAE			
		E	Callistopteris baldwinii (Eaton) Copel.	
		E	Mecodium recurvum (Gaud.) Copel.	'ohi'a-lu
		E	Sphaerocionium lanceolatum (Hook. & Arn.) Copel.	palai-hinahina
		E	Sphaerocionium obtusum (Hook. & Arn.) Copel.	Palai-lau-li'i
		E	Vandenboschia cyrtotheca (Hillebr.) Copel.	
		E	Vandenboschia davallioides (Gaud.) Copel.	palai-hihi
	LYCOPODIACEAE			
		E	Lycopodium phyllanthum Hook. & Arn.	wawae-'iole
	NEPHROLEPIDACEAE			
		I	Nephrolepis cordifolia (L.) Presl	ni'ani'au, kupukupu, 'okupukupu
		I	Nephrolepis exaltata (L.) Schott	ni'ani'au, kupukupu, pamoho
		X	Naphrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern
	OPHIOGLOSSACEAE			
		E	Ophioglossum pendulum L. ssp. falcatum (Presl) Clausen	puapua-hoe
	POLYPODIACEAE			
		I	Pleopeltis thunbergiana Kaulf.	'ekaha-kakolea, pakahakaha
	PSILOTACEAE			
		I	Psilotum complanatum Sw.	moa, pipi
		I	Psilotum complanatum X nudum	hybrid moa
		I	Psilotum nudum (L.) Beauv.	moa, pipi
	THELYPTERIDACEAE			
		X	Christella dentata (Forsk.) Brownsey & Jermy	downy woodfern
		X	Christella parasitica (L.) Levl.	woodfern, oakfern
		E	Pneumatopteris sandwicensis (Brack.) Holtt.	

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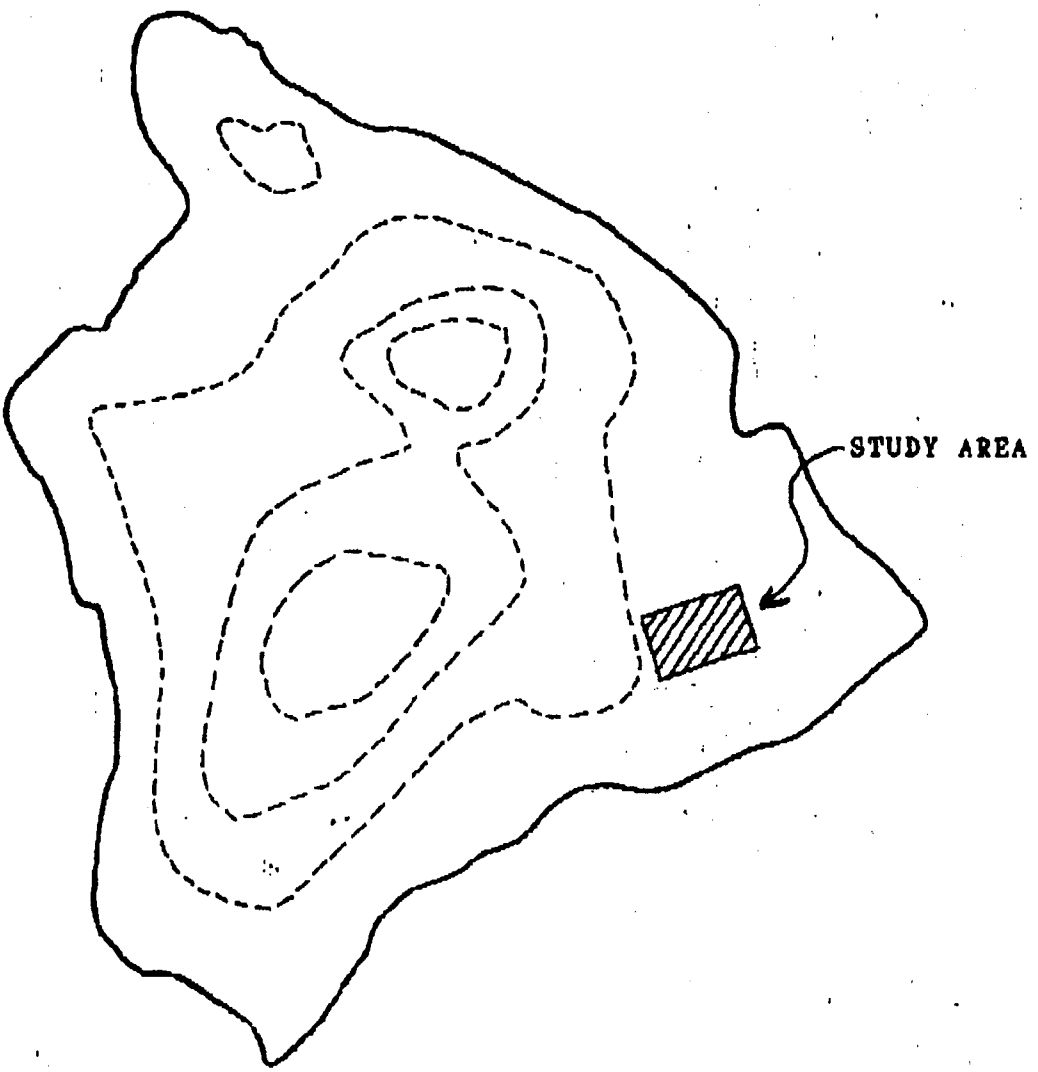
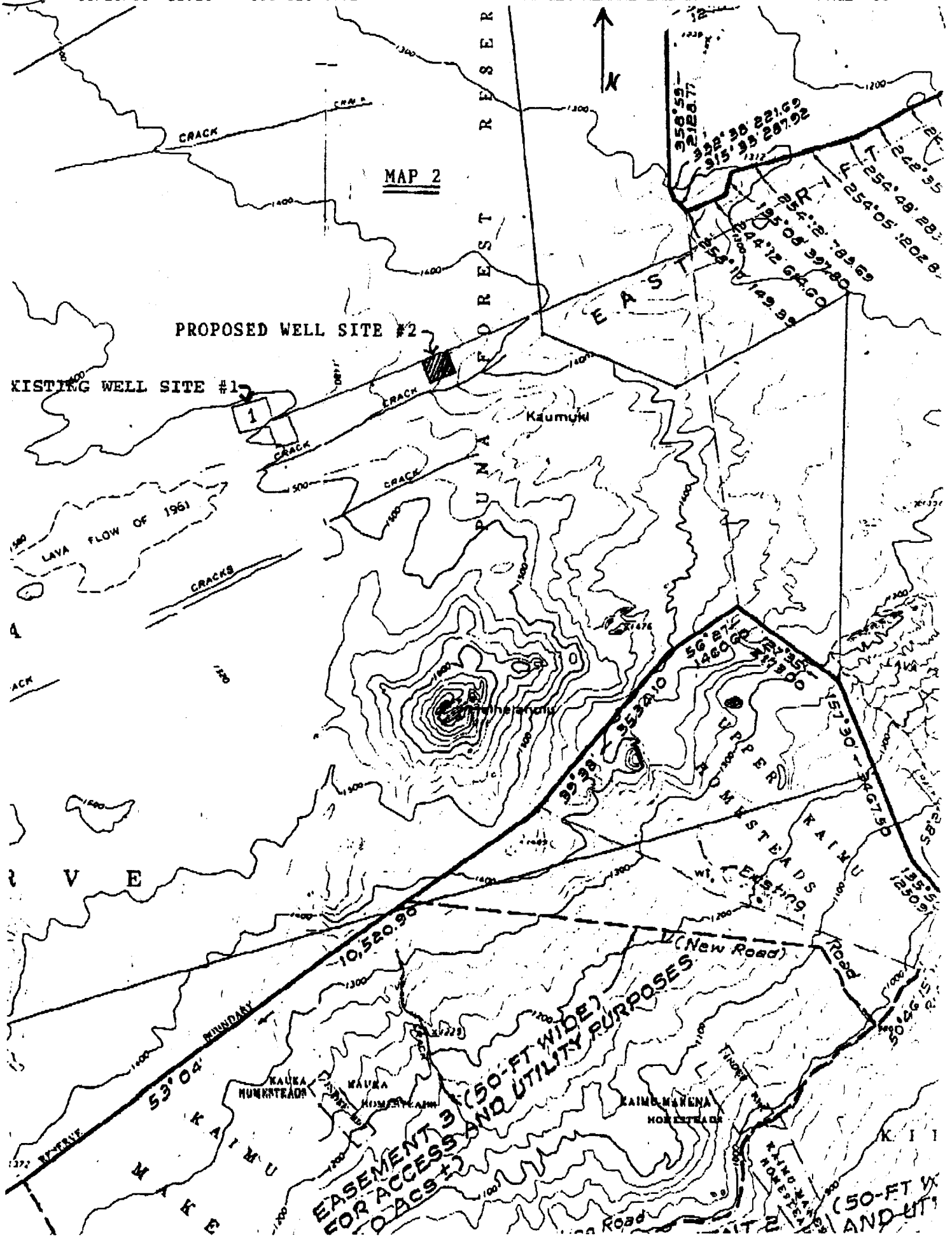
GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
MONOCOTYLEDONS				
	CYPERACEAE			
		X	Cyperus haspan L.	
		I	Machaerina mariscoides (Gaud.) Kern ssp. meyenii (Kunth) Koyama	'uki, 'aha-niu
		I	Pycreus polystachyos (Rottb.) Beauv.	
	GRAMINEAE			
		X	Axonopus affinis Chase	narrow-leaved carpetgrass
		X	Oplismenus compositus (L.) Beauv.	
		X	Paspalum conjugatum Berg.	mau'u-Hilo, Hilo grass
	ORCHIDACEAE			
		X	Arundina bambusaefolia (Roxb.) Lindl.	bamboo orchid
		X	Spathoglottis plicata Bl.	Philippine ground orchid
	PANDANACEAE			
		E	Freycinetia arborea Gaud.	'ie'ie
	ZINGIBERACEAE			
		P	Zingiber zerumbet (L.) Roscoe	'awapuhi kuahiwi
DICOTYLEDONS				
	APOCYNACEAE			
		E	Alyxia olivaeformis Gaud.	maile
	AQUIFOLIACEAE			
		E	Ilex anomala Hook. & Arn.	kawa'u
	CELASTRACEAE			
		E	Perrottetia sandwicensis Gray var. sandwicensis	olomea
	COMPOSITAE			
		I	Adenostemma lavenia (L.) Ktze.	kamanamana
		X	Ageratum houstonianum Mill.	ageratum
		X	Crassocephalum crepidioides (Benth.) S. Moore	
		X	Erechtites valerianaefolia (Wolf) DC.	fireweed
	ERICACEAE			
		E	Vaccinium calycinum Sm.	'ohelo-kau-la'au
	EUPHORBIACEAE			
		E	Antidesma platyphyllum Mann	hame
	GESNERIACEAE			
		E	Cyrtandra paludosa Gaud.	
		E	Cyrtandra sp.	
	LOBELIACEAE			
		E	Clermontia parviflora Gaud. ex Gray	
		E	Clermontia hawaiiensis (Hillebr.) Rock	'oha-kepau
	LOGANIACEAE			
		X	Buddleja asiatica Lour.	butterflybush, huelo-'ilio

TABLE 1. PLANT CHECKLIST: NEW WELL SITE 2 AND ITS ACCESS ROAD.

GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
	LYTHRACEAE			
		X	Cuphea carthagenensis (Jacq.) Macbride	cuphea, pukamoli
	MELASTOMATACEAE			
		X	Melastoma malabathricum L.	Malabar melastome
	MYRTACEAE			
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. glaberrima (Levl.) Rock	'ohi'a-lehua
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. incana (Levl.) Rock	'ohi'a-lehua
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. macrophylla Rock	'ohi'a-lehua
		X	Psidium cattleianum Sabine forma cattleianum	strawberry guava, waiawi-'ula
		X	Psidium guajava L.	guava, kuawa
	ONAGRACEAE			
		I	Ludwigia octivalvis (Jacq.) Raven	kamole, primrose willow
		X	Ludwigia palustris (L.) Ell.	water purslane
	PIPERACEAE			
		E	Peperomia cookiana C. Dc.	'ala'ala-wai-nui
		E	Peperomia hypoleuca Miq. var. hypoleuca	'ala'ala-wai-nui
	ROSACEAE			
		X	Rubus rosaefolius Sm.	thimbleberry
	RUBIACEAE			
		E	Coprosma menziesii Gray	pilo, kopa
		E	Coprosma ochracea W. Oliver	pilo, kopa
		E	Psychotria hawaiiensis (Gray) Fosb. var. hawaiiensis	kopiko
	SAXIFRAGACEAE			
		E	Broussaisia arguta Gaud.	kanawao
	URTICACEAE			
		E	Pipturus hawaiensis Levl.	mamaki

MAP 1




MAP 2
PROPOSED WELL SITE #2
EXISTING WELL SITE #1
1
CRACK
LAVA FLOW OF 1961
CRACKS
Kaumuki
Kaumuki Cone
EAST RIFT ZONE
SOUTHWEST RIFT ZONE
UPPER KAIMU HOMESTEADS
KAIMU
MAKENA
KAUKA HOMESTEAD
KAIMU-MAKENA HOMESTEAD
MAKENA HOMESTEAD
10,520.90
(New Road)
Road
BOUNDARY
53°04'
EASEMENT 3 (50-FT WIDE) FOR ACCESS AND UTILITY PURPOSES
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